A Case Study of the Research-to-Operations (R20) Process at HMT-WPC

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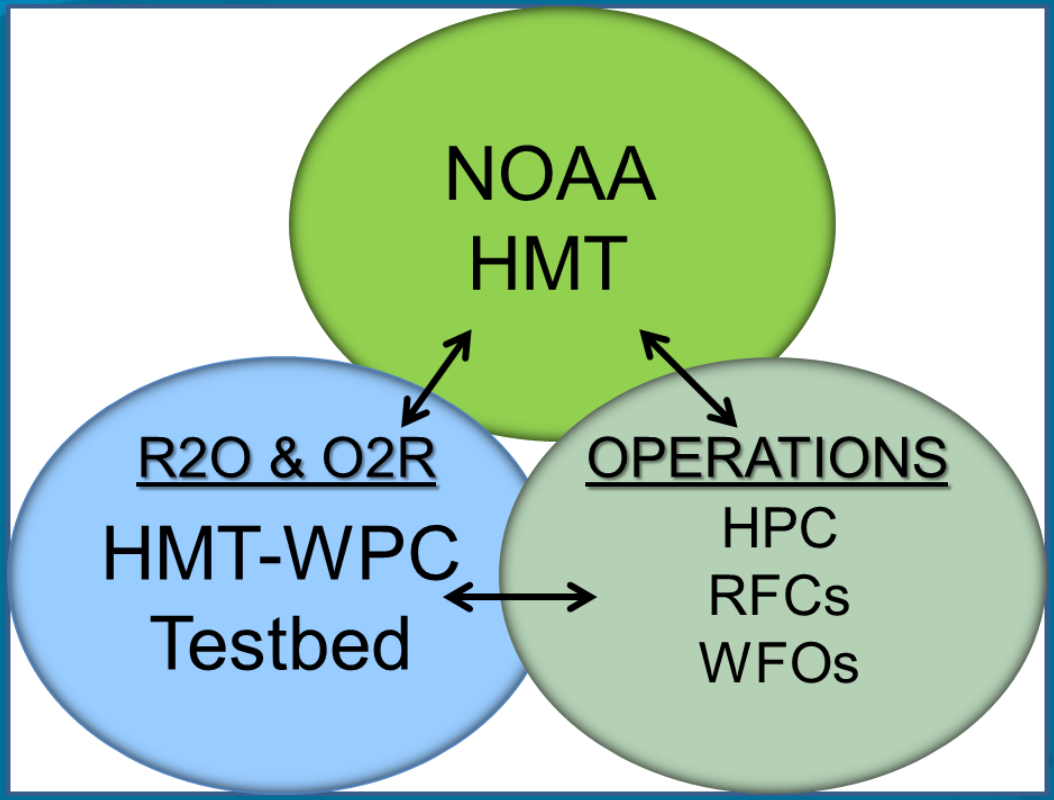
HMT-WPC: What do we do?



Accelerate the transfer of scientific and technological innovations into operations to enhance WPC products and services.

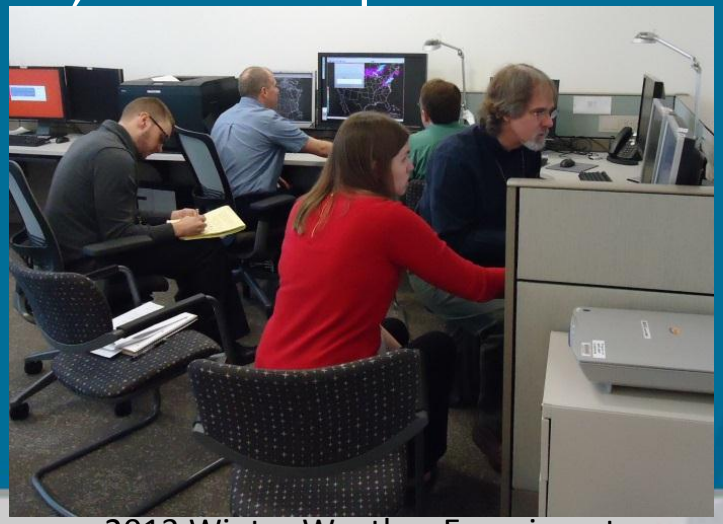
R20: How it works

Three-step transition process

1. Development and testing of new datasets, models and techniques
   - » Real-time/retrospective forecasting experiments
2. Subjective and objective evaluation
3. Operational training and implementation

Experiments:

Test new models, guidance, tools, products in (pseudo) *real* time, with *real* forecasters, in a *real* operational meteorology setting



2013 Winter Weather Experiment

I) The Issue: Improve Numerical Model Snowfall Guidance

- Numerical model prediction of snowfall is still an "inexact" science that suffers from several issues:
  - The precipitation-type (p-type) conundrum
    - Instantaneous P-type
  - The snow-to-liquid ratio (SLR) conundrum
    - Snowfall = QPF x SLR
    - How do we get the SLR right?
  - The snowfall vs. snow accumulation conundrum
- Collaboration with EMC/NAM
  - Mike Bodner (HMT-WPC) and Brad Ferrier (EMC)

NAM Rime Factor-Modified Snowfall Accumulation

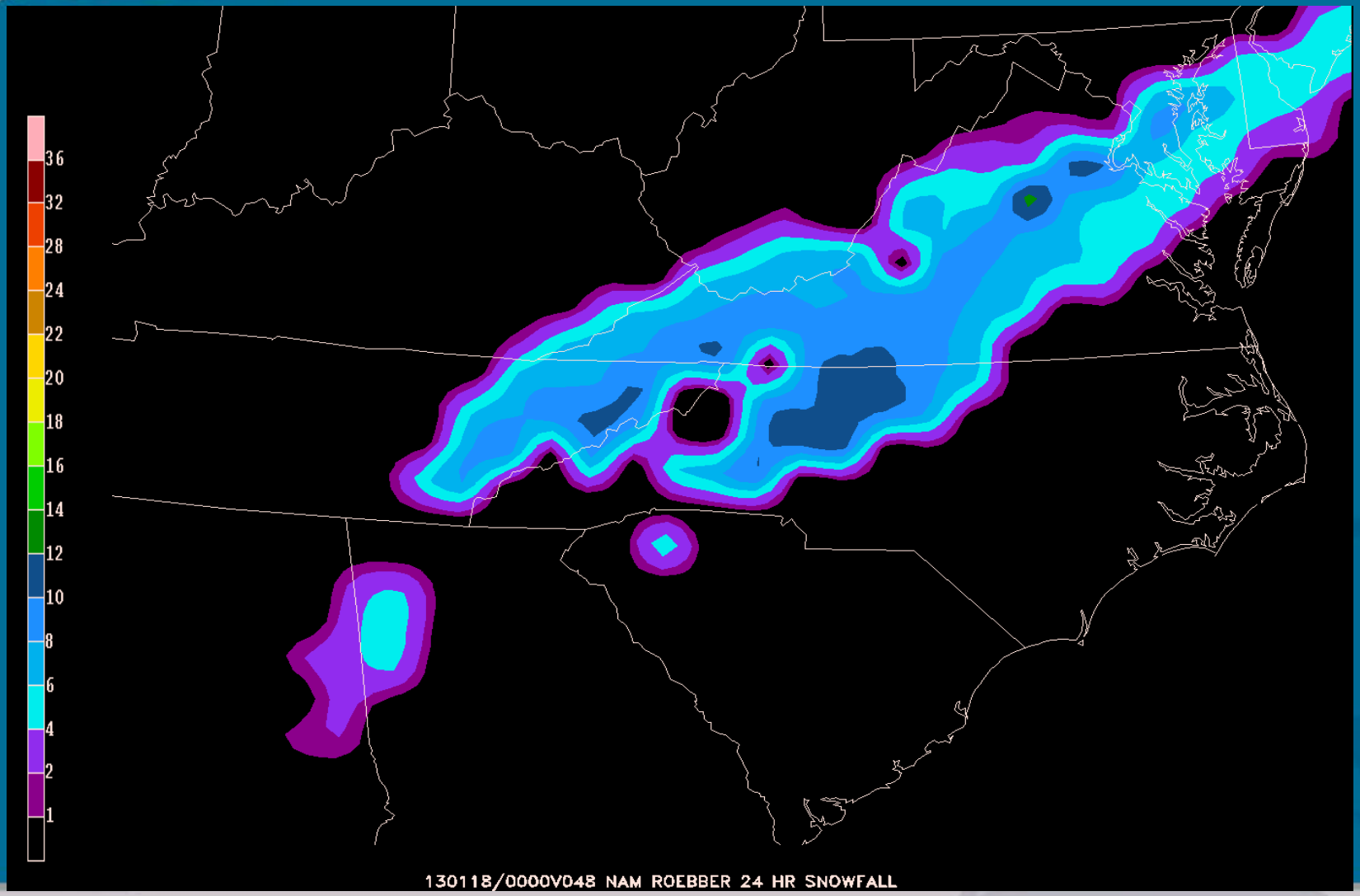
- Roebber snowfall (SLR) technique*
  - Roebber, P. J., S. L. Bruening, D. M. Schultz, and J. V. Cortinas, 2003: Improving snowfall forecasting by diagnosing snow density. *Wea. Forecasting*, **18**, 264-287.
- Modifies Roebber SLR by considering the percentage of frozen precipitation and the rime factor
  - Percent Frozen QPF (*instantaneous*) – percent of precipitation reaching the ground that is frozen
  - Rime Factor (*instantaneous*) – indicates amount of growth of ice particles by riming and liquid water accretion

1 < RF < ~2	no change to Roebber SLR	fluffy (unrimed) snow
~2 < RF < ~5	Roebber SLR reduced by factor of 2	rimed snow
~5 < RF < ~20	Roebber SLR reduced by factor of 4	graupel
RF > ~20	Roebber SLR reduced by factor of 6	sleet (frozen drops)

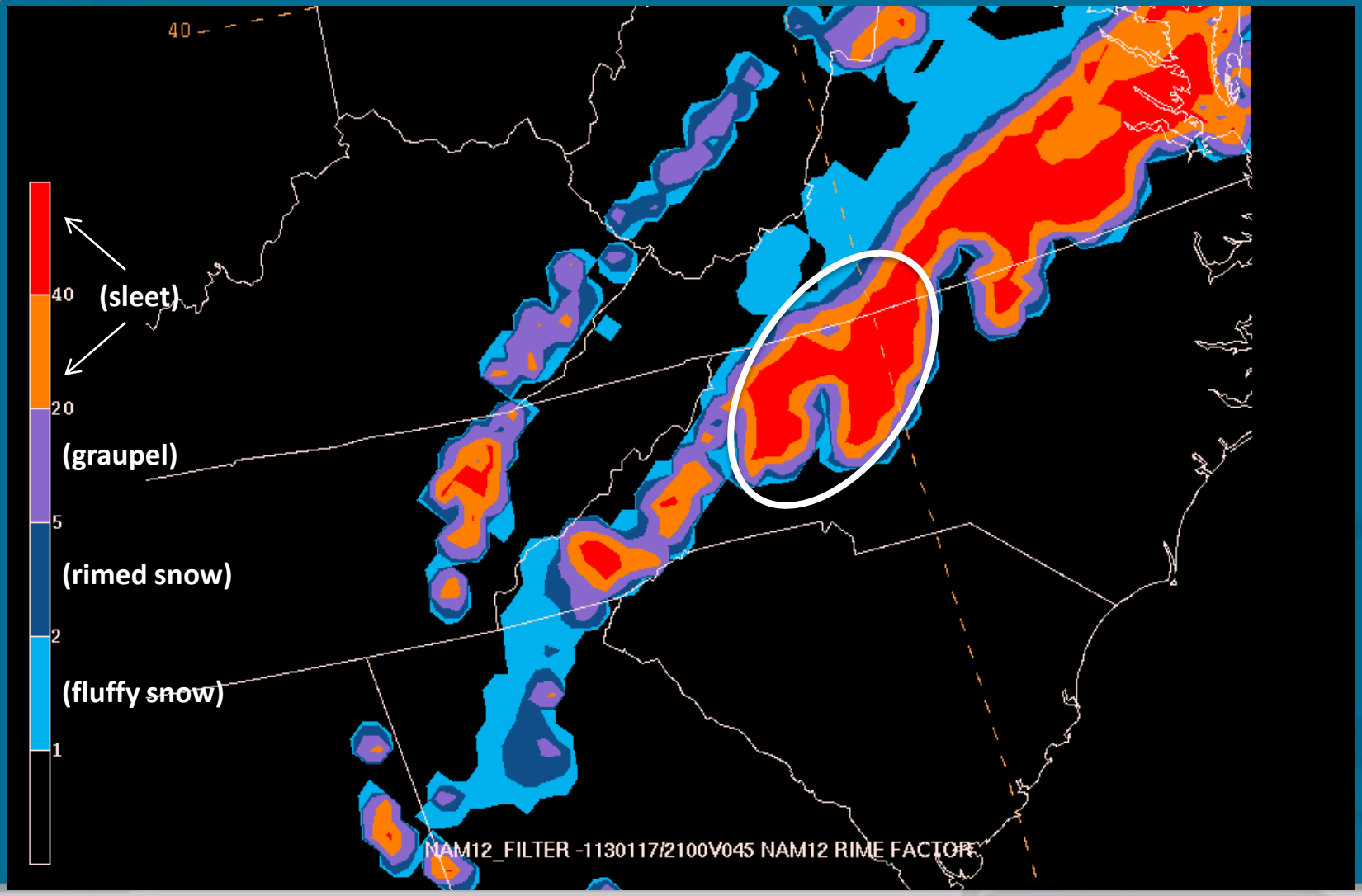
- *Evaluated during the 2013 Winter Weather Experiment*
  - *Probability of exceedance forecasts (e.g. 2", 4", 8")*
  - *Decision support*

Courtesy of Brad Ferrier (EMC) and Faye Barthold

NAM Roebber 24 hour Snowfall Valid 00Z Jan 18, 2013



NAM Filter Rime Factor
Valid 21Z Jan 17, 2013



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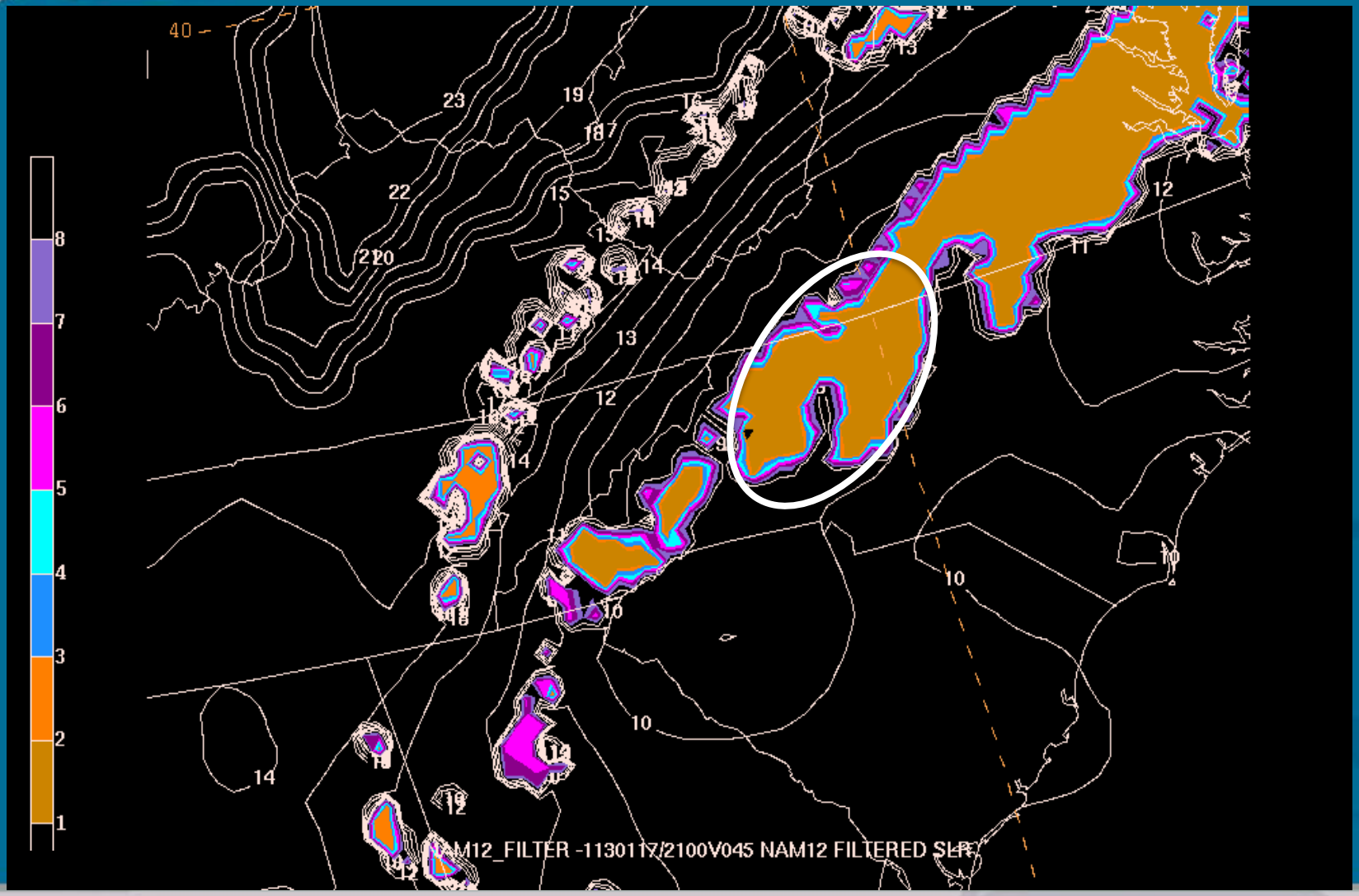
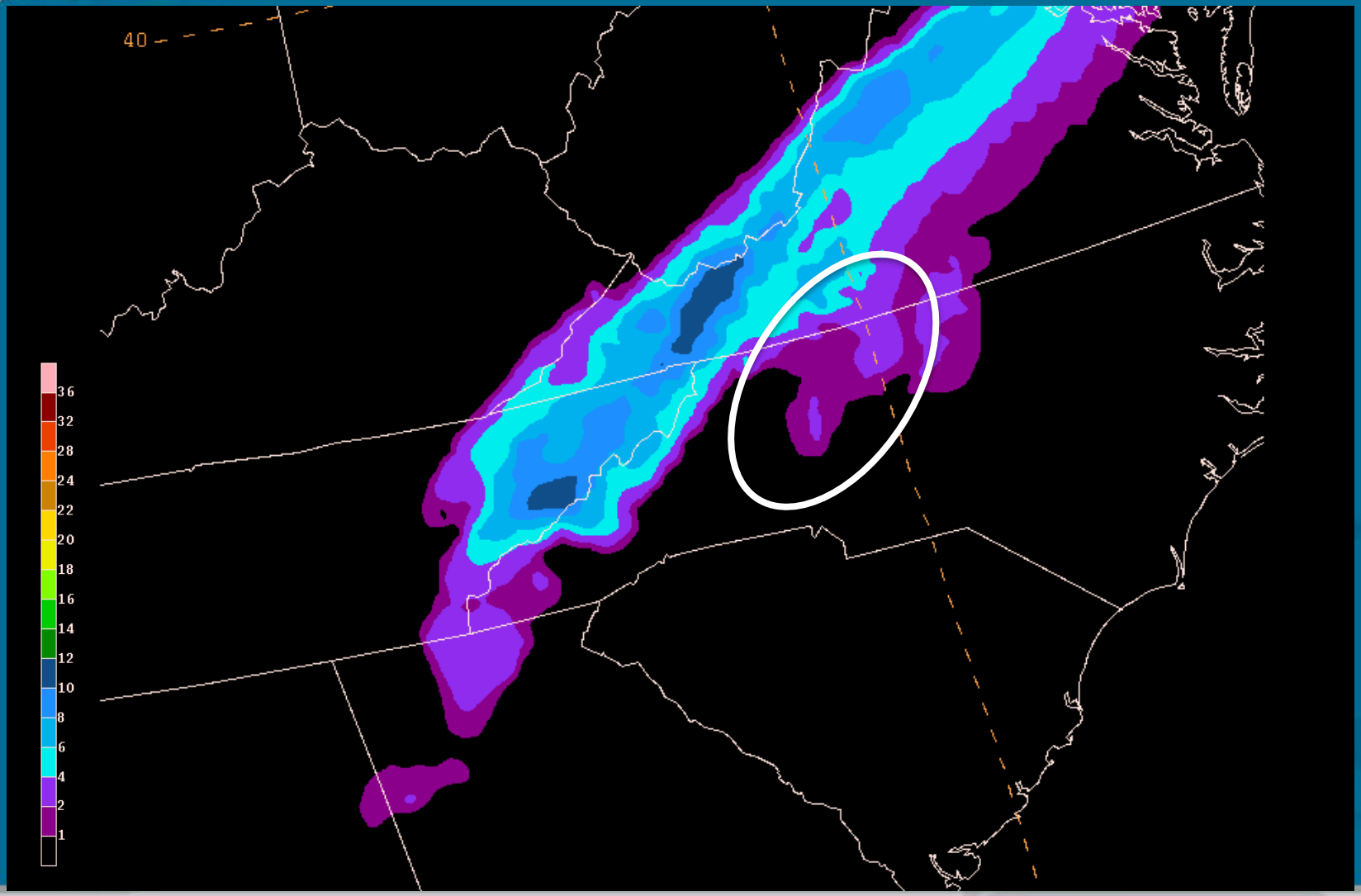
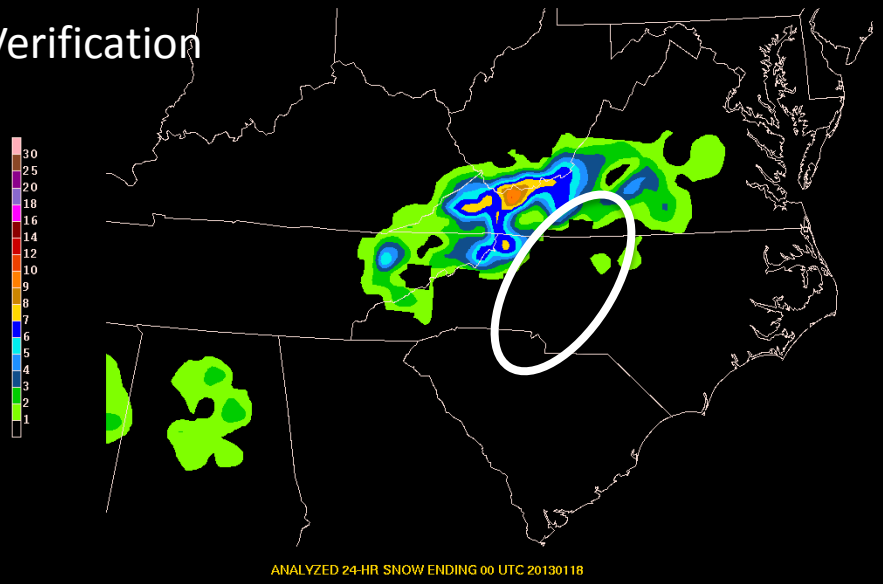


NAM Rime-Factor 24 hour Snowfall Valid 00Z Jan 18, 2013

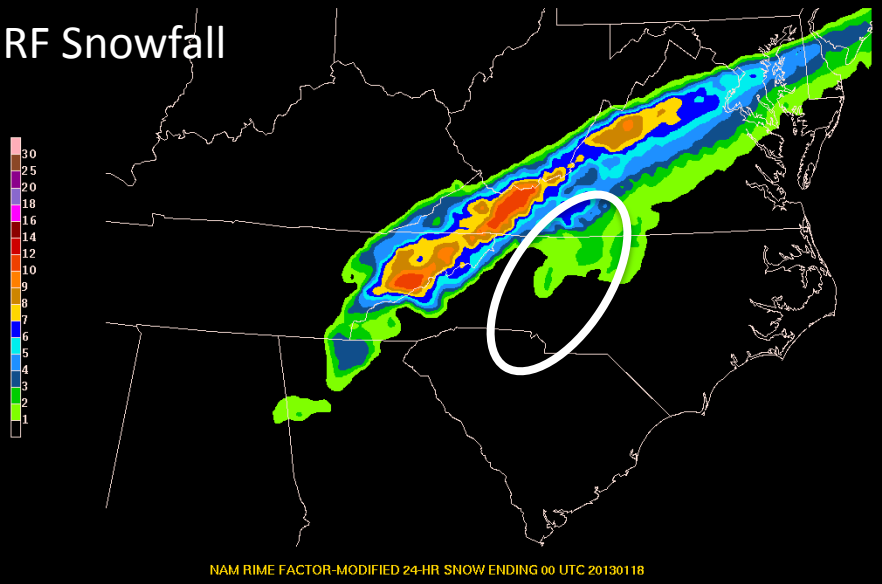


Verification: An Example

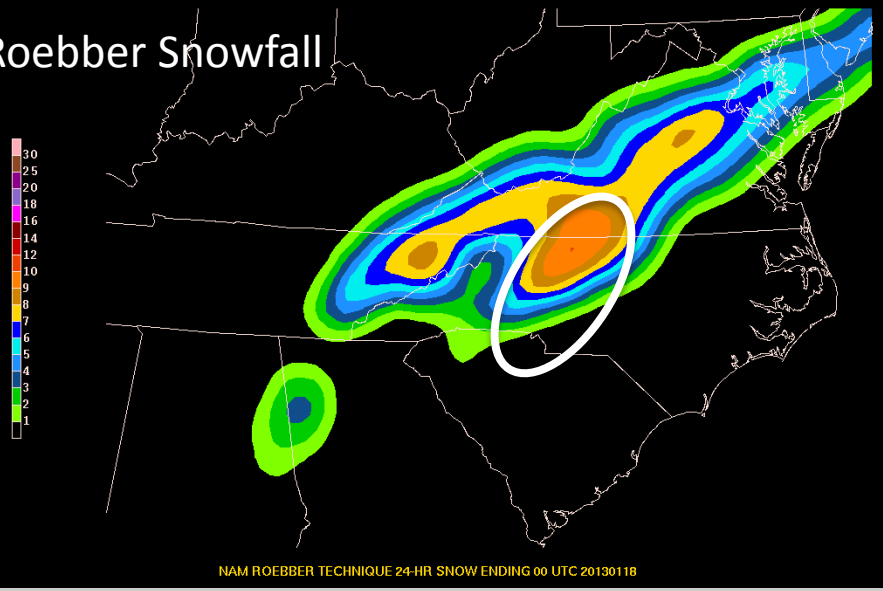
Verification



RF Snowfall



Roebber Snowfall



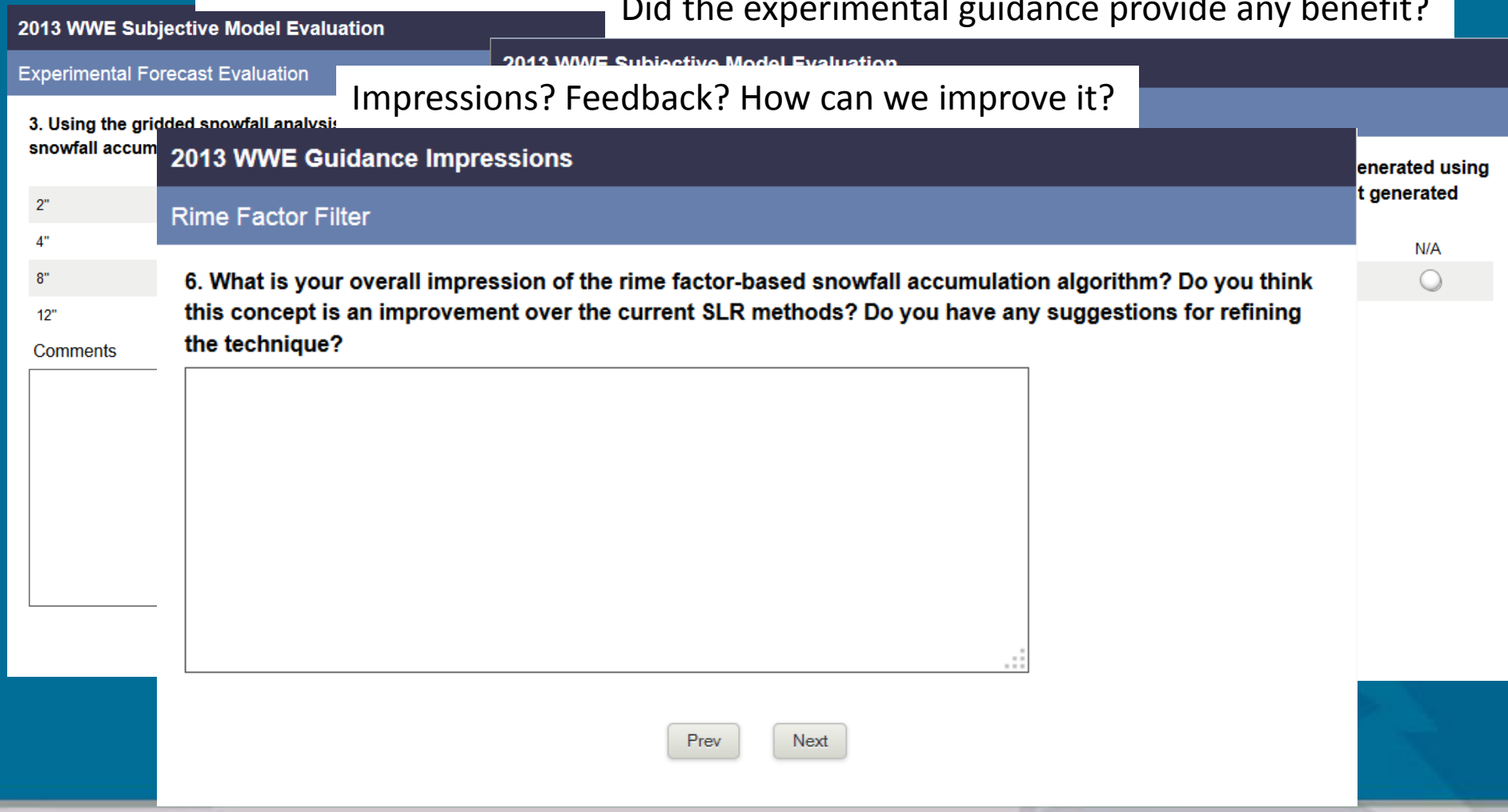
"….in areas of north central North Carolina where the high rime factor/low fraction of frozen precip the latter half of the forecast and short duration of high percent frozen suggest lower amounts will fall."

A Penny for Your Thoughts?

How accurate was your fc[illegible]?

Did the experimental guidance provide any benefit?

Impressions? Feedback? How can we improve it?



WWE Results, and What Now?

- Overall favorable reception
  - Rime factor, Percent frozen precip, SLR modification
  - Helps identify areas where precipitation-type could be a concern
- Main drawbacks:
  - Only applied to the NAM (and its QPF)
  - Resolution differences made comparison to standard NAM Roebber snowfall difficult
- Going forward:
  - Expanding to all forecast cycles (only available at 00Z)
  - Implementation on 32km grid? (currently produced at 12 km)
  - Apply it to SREF or GFS?
  - Combine snowfall forecast with land use parameterization → potentially improve accumulation forecasts(?)

II) The Issue: Improve Predictability of Extreme Precipitation Events along the West Coast

- QPFs are challenging
  - Amounts, location & timing difficult
  - Especially in mid-range timeframe
- Influence of WPC products
  - Excessive rainfall
  - Medium range QPF

- *2012 Atmospheric River Retrospective Forecasting Experiment (ARRFEX)*
  - *8 retrospective AR cases*
  - *Tested experimental data sets in creating 72 hour QPF and probability of exceedance forecasts*

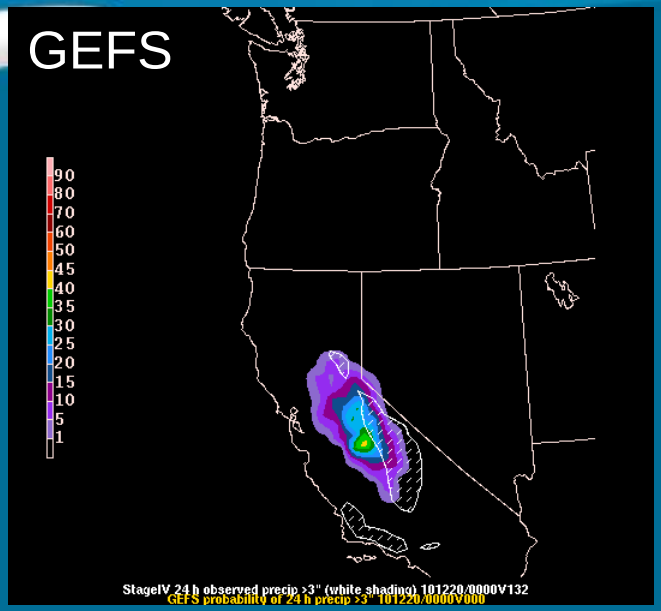
ESRL 2nd Generation Reforecast Dataset

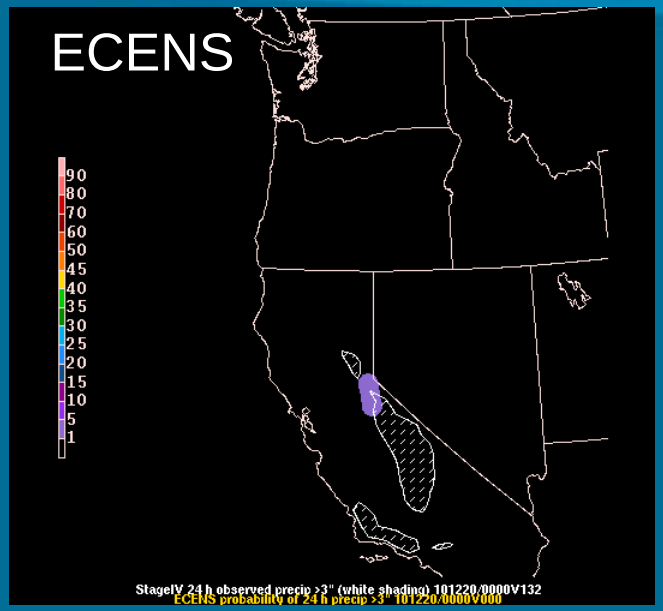
- 2nd generation GEFS (version 9.0.1); 1985-2010
- 10 members plus control run; archive 00Z initializations
- Ranked analog method at each grid point to find dates of closest 50 matches
  - NARR precipitation data (32 km)
  - 24 hr PQPF and mean QPF
- Removes model QPF biases; uses observations of past events to make forecasts

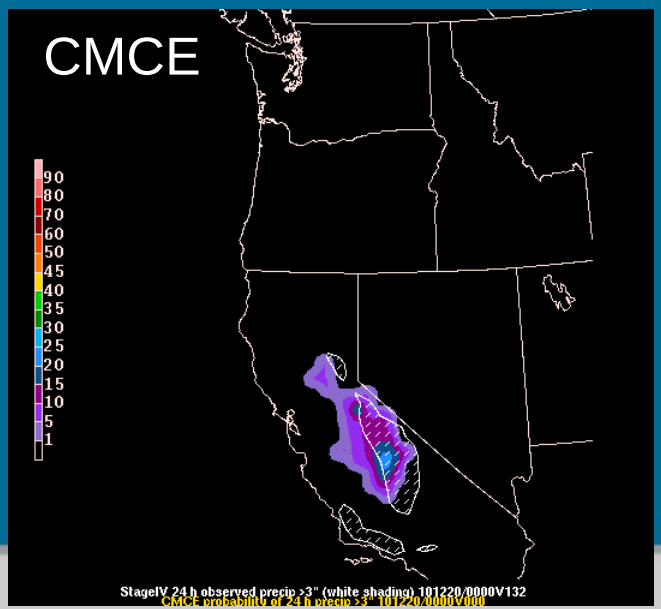
http://www.esrl.noaa.gov/psd/forecasts/reforecast2/

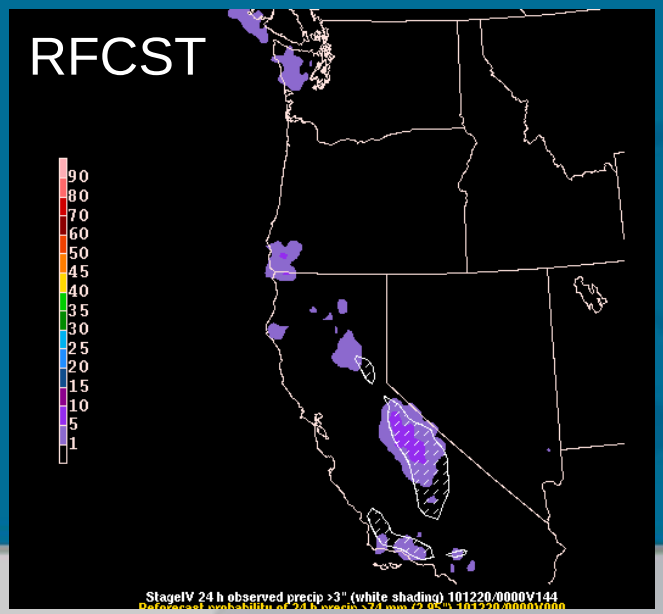
Hamill, T. M, and co-authors, 2013: NOAA's second-generation global medium-range ensemble reforecast data set. *Bull. Amer. Meteor. Soc.,* Early Online Release.

Probability of >3” in 24 hours
5-day Forecast



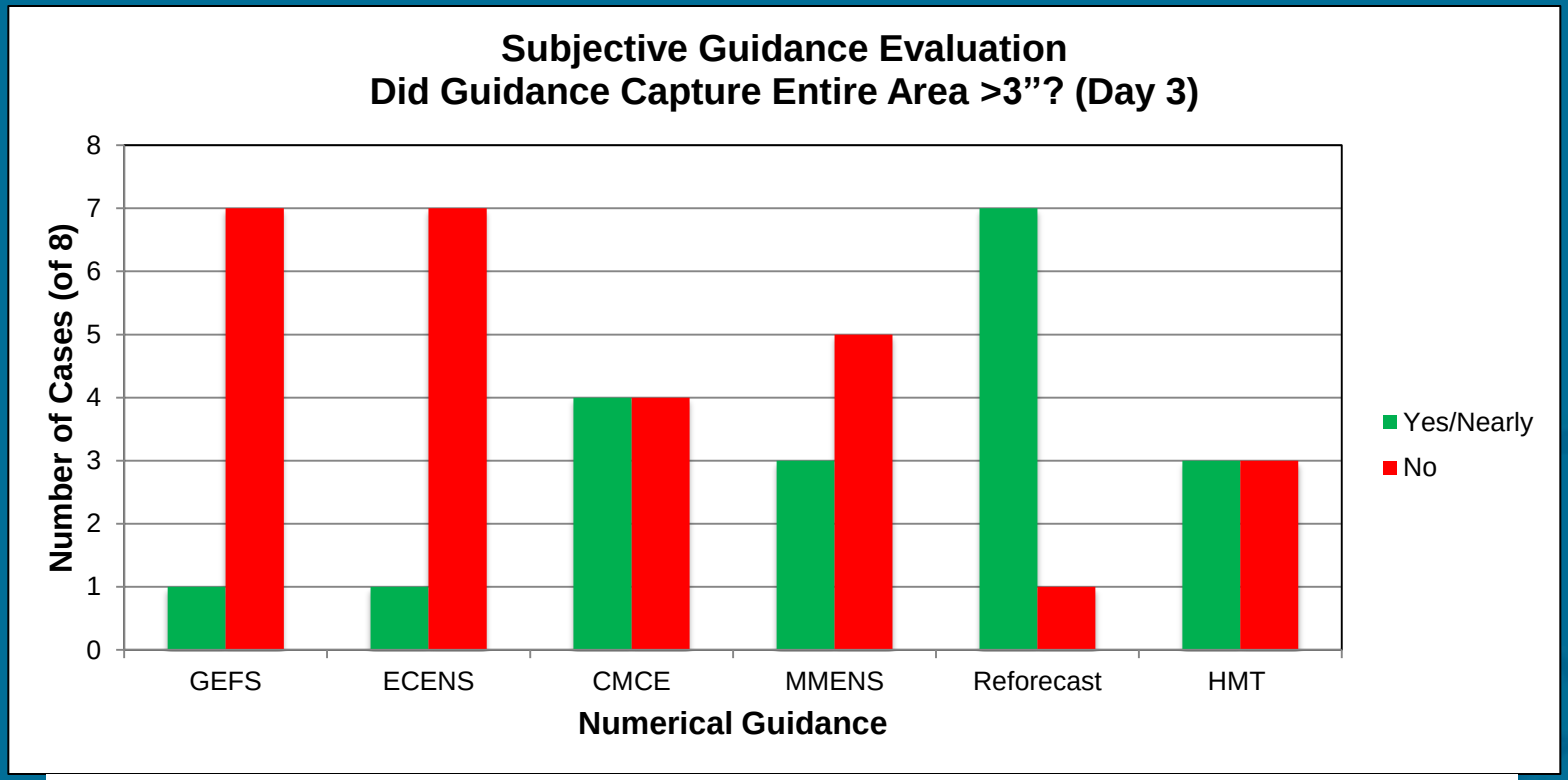






ARRFEX Results, and What Now?

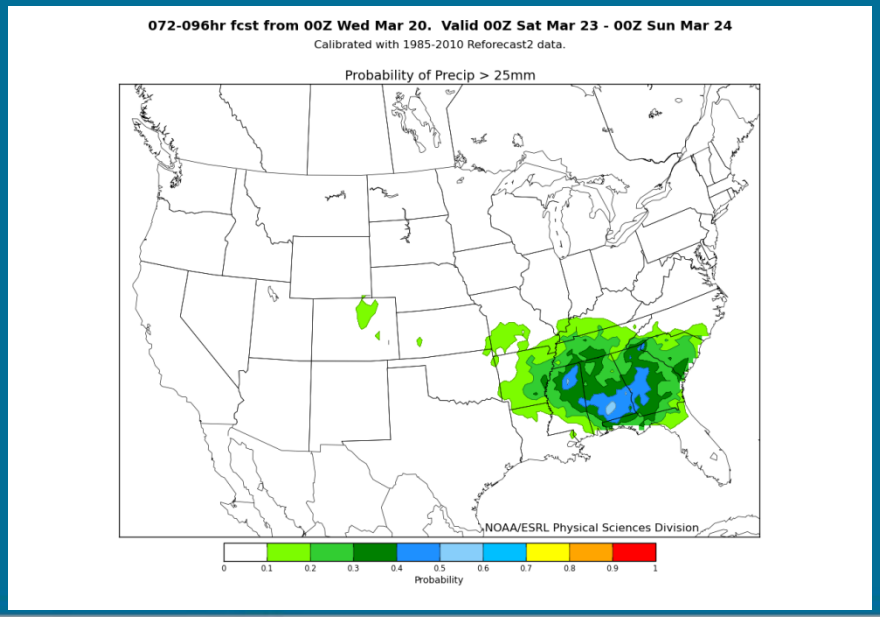
- Forecasters reacted favorably to the reforecast dataset, particularly in its ability to identify areas at risk for heavy precipitation at mid-range lead times

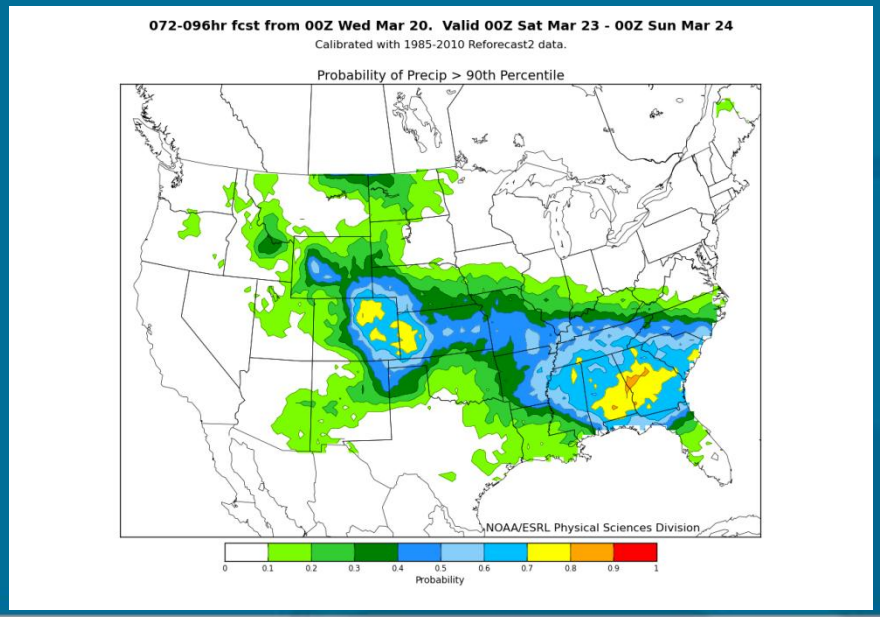


→ Reforecast deemed 'most helpful' in 6 cases (CMCE: 1, HMT: 2)

ARRFEX Results, and What Now?

- Collaboration between WPC-HMT and ESRL on development of reforecast products:
  - Probability of exceedance
  - Percentiles (climatology)
  - Deterministic (mean QPF)
  - Extreme Forecast Index
- Working on getting WPC direct access to the reforecast dataset for continued in-house development (e.g. dataflow)





Credit: Tom Hamill and Gary Bates, ESRL

What You Should Take Away…

TEST → EVALUATE → TRAIN AND IMPLEMENT

- WPC-HMT continually works with colleagues to investigate ways to improve WPC operations

A Few Examples:

Ensemble Sensitivity Tool (SUNY Stonybrook)	Storm Scale Ensemble of Opportunity (SPC)
SREF parallel (EMC)	Ensemble Clustering (EMC)
AFWA High-Resolution Ensemble (AFWA)	HMT-Ensemble (ESRL/HMT)
GEFS 2nd Generation Reforecast Dataset (ESRL)	NAM Rime-Factor Modified Snowfall (EMC)

- For the WPC, testing in the operational setting is imperative
  - Experiments → *it's not just about objective scores*
- Implementation can be a big hurdle
  - Proper data formatting and dependable dataflow to meet requirements

Beneficial → Efficient → IT Compatible → Sustainable